Default Risk and the Cross-Section of UK Insurance Firms' Returns

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Abstract

In this paper, we use a novel data-set of UK public and non-public insurance firms between 1985-2014 to investigate the empirical relationship between insurance firm's returns and default risk as well as between industry default risk and reinsurance activity. We investigate whether some important firm's characteristics (particularly, size and reinsurance) can help us to understand that relationship. We employ a novel cross-sectional portfolio approach and, after splitting returns into underwriting and investment returns, find evidence that default risk is negatively related to firms' returns, while it is closely related to size and reinsurance activities especially for small size firms. We also report empirical evidence showing that returns in the insurance industry are exposed to a common risk factor.

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1. Introduction

"Historically, insurers have made money in two ways – returning an underwriting profit and investing premiums and making money on the investment returns." By Nick Kitchen, Head of Technical Casualty and Motor Lines, Zurich Insurance plc.

The UK's general insurance industry is worth £60bn annually and it is the largest in Europe and the third-largest in the world (after the US and Japan). It comprises more than 500 firms (both domestically and foreign-owned). Previous studies have generally focused on public-listed insurers, for which it is possible to collect stock prices. However, by doing so, they appear to have significantly limited the scope of the analysis, as a large proportion of UK insurance firms, unlike life insurance firms, are unlisted companies. For example, about 80% of UK general insurance firms are non-public. In this paper, we employ a new dataset of UK listed and non-listed firms, thus relying on a much larger sample than previous investigations.

While a large part of the literature on default risk focuses on valuing financial instruments (e.g. Duffie and Singleton, 1999; Longstaff and Schwartz, 1995), we do not take this direction. We focus on how default risk relates to insurance firm's returns via some firm's characteristics and if these characteristics can help us to better understand that relationship. This topic represents a significant contribution for many reasons. First, insurance valuation and underwriting risk models can be divided into two major blocks: Capital Asset Pricing (CAPM) models (Cummins and Harrington, 1985; Fairley, 1979; Ben Ammar et al, 2018), and option pricing models (Doherty and Garven, 1986). While the former does not consider default risk, the latter does when determining firms' returns. Second, industry-based models of insurance are generally CAPM based models and these models are supported by a large empirical literature. On the other hand, although a significant body of the theoretical literature on option pricing models exists, there is somehow, a lack of empirical evidence. This motivates us to understand the empirical validity of these insurance models.

Another novel contribution of our paper consists of using an asset pricing (portfolio) approach based on exploiting the cross-sectional variation of our large dataset. Our portfolio approach allows us to disentangle the contribution of a particular firm's characteristics on the return-risk relationship. This is the first insurance study to introduce this empirical approach.

An additional contribution of our paper is to show that size and reinsurance contain important default related information and it sheds some light on this important research area, which is yet far from reaching clear-cut conclusions.

Finally, the paper also contributes to the literature on systemic risk, insurance firms and its linkages with the financial markets. Insurance firms are key intermediaries in many financial assets (bonds, money market funds, etc…) and therefore highly interconnected with the financial markets. Their reluctance to intermediate assets, because of increasing (industry) systemic risk, could trigger losses spreading to the financial sector and fairing back to the insurance market via assets' depreciation. We acknowledge that traditional insurers (the small and, in part, the large ones) are better diversified in terms of risks and they experience illiquidity problems mainly when they make poor business decisions, in this way their contribution to systemic risk is likely to be smaller. Our argument, in this paper, is that today the industry as a whole is no longer the sort of "traditional" industry, as it is greatly interconnected with the financial industry and is an important player in the intermediation of important asset classes, fixed income and money market funds. Our paper uncovers a new, possible, transmission mechanism connecting the insurance industry to the financial markets.

Some of the results in our paper relate to the asset pricing literature, which explores the existence of anomalous cross-sectional properties of stock returns via default risk. Examples of these are Vassalou and Xing (2004) and Campbell et al. (2008). These papers investigate how default risk is associated with a number of different firms' characteristics (for example, size and book-to-market ratio), and if it helps to explain why we observe different returns for stocks issued by different distressed firms. While Vassalou and Xing (2004) show that size and book-to-market are important factors to explain the default risk-return relationship for stocks, and that investors demand a premium to buy high default risk stocks, Campbell et al. (2008) show that stocks with higher default risk tend to have lower future returns.

Our study departs from that literature in several different ways. It uses PRA (Prudential Regulation Authority) returns data (i.e. regulatory data from the Bank of England), as the vast majority of the firms in our sample are not listed. It focuses on the insurance industry, while most of the above literature has concentrated on non-financial firms. It shows a negative relationship between firms' returns and default risk in the UK insurance industry.

We investigate if and how some firm's characteristics, particularly size and reinsurance[4], can help us to explain the negative relationship between returns and default risk. In so doing, we contribute to the strand of the literature that investigates how default risk links to these factors. There is a large literature in the insurance arena that investigates what drives default risk. This is a relevant topic today, as insurance firms are becoming more and more interconnected with the financial system and are becoming more and more complex structures. The insurance sector represents nowadays a significant portion of the whole financial industry. The possibility that failures of insurance companies (for which risk is by definition an intrinsic element of their activity) can produce contagion effects in the economy should not be underestimated. This is particularly relevant when considering the increasingly intertwined world as well as taking into account the latest important changes in the operating environment of insurance firms (like technological advances and the growing complexity of insurance products). Therefore, the soundness of insurance firms is an important issue for both agents and policymakers, who face major challenges as regards the reduction of insolvency risk and the promotion of confidence in the financial stability of the insurance sector (Pasiouras and Gaganis, 2013; Caporale et al., 2017). For example, Caporale et al. (2017) find that default risk is associated to reinsurance activity; however, they conjecture its consequences for the stability of the insurance industry but do not investigate this crucial issue further. Our results help us to shed some light on this part of the literature as well, as we show that insurance firms' returns (underwriting and investment) share a common risk making the industry more exposed to systemic risk.

Why do we use size and reinsurance to investigate the return-risk relationship? Surely, the relationship between a firm's size and default risk in the insurance industry has found great attention. For example, Bouzouita and Young (1998) find that large insurers are less likely to become insolvent, as they normally benefit from economies

[4] Reinsurance is here measured as the ratio of Reinsurance Premiums Ceded to Gross Premium written.

of scale and, given their sizeable market shares and higher ratings, have lower financing costs than small insurers (Adams et al., 2003), while Caporale et al. (2017) report that size is not significant in explaining insurer's insolvency risk. Thus, the literature is yet far from reaching a clear-cut conclusion. We show that size contains important default related information. We are able to show this novel result as our empirical setting allows us to disentangle the firm's size into the small, medium, and large categories, and to relate them to default risk and returns. This cross-sectional (portfolio) approach is new in the insurance literature, and produces some novel and interesting results.

Reinsurance is another firm's characteristic that we consider in this study (see Lei, 2019). Insurance firms buy reinsurance and cede a significant portion of the premium to the reinsurer to hedge off risk from the balance sheet, freeing in this way capital that they can invest in the new core business, i.e. to write new insurance policies. However, regulators attempt to limit the potential for catastrophic losses by requiring insurers to maintain sufficient capital. For example, firms are asked to hold enough capital to meet the solvency capital requirement (SCR) and minimum capital requirement (MCR) under *Solvency II*. Thus, reinsurance could be used not only as a hedging tool that enables primary insurers to transfer risks to third parties, but it can also be used to free capital for the primary insurers for non-core activities. In so doing, insurers are exposed to the counterparty risk of reinsurers (e.g., when reinsurers are insolvent or run-off, insurers will have to pay the claims to the policyholders-skin in the game). The fast-growing of reinsurance for primary insurers may lead to higher potential losses in the future. To what extent the reinsurance market is associated with an increase (decreases) of default risk, and how it affects returns, are intriguing questions that we aim to answer.

Reinsurance risk has been extensively studied in the insurance literature so far. Among others, Harris and Raviv (1991) show that reinsurance affects the strategic performance of a firm, Harrington and Niehaus (2003) argue that reinsurance is important for solvency risk, Caporale et al. (2017) find that reinsurance increases default risk, and Acharya and Richardson (2009) point out that default risk in the insurance industry could spread to the financial industry too.

Our paper links to the above literature in many respects. It shows that reinsurance contains important default related information. That is, reinsurance and default risk are positively related. Our paper also shows that higher default risk firms are more involved in reinsurance trigging down firms' returns and increasing systemic risk in the insurance industry. This evidence is in line with the adverse selection hypothesis (Stiglitz, 1977) and the rental capital hypothesis (Shiu, 2011) and we discuss it from a policy perspective.

To sum up, we study empirically if and how reinsurance and size contain default related information which help us to understand the return-risk relationship in UK general insurance firms and if and how the reinsurance market contributes to enhancing systemic risk in the UK insurance industry.

The remainder of the paper is organized as follows. Section 2 introduces the model and briefly reviews the relevant literature. Section 3 reviews the data and summary statistics. Section 4 explores how default risk relates to insurers' asset returns. Section 5 discusses the cross-sectional regression results. Section 6 summarizes the main findings and offers some concluding remarks.

2. The Model

We employ reduced-form models, as in Caporale et al. (2017). These models have become increasingly popular in the last few years for computing default probabilities of individual firms. Duffie et al. (2007) introduced a doubly stochastic Poisson model with time-varying covariates and used it to forecast the evolution of covariate processes within a Gaussian panel vector auto-regression model. That model has been further extended by Duan et al. (2012), who applied a pseudo-likelihood method to derive the forward intensity rate of the doubly stochastic Poisson processes at different time horizons.

The Poisson process with stochastic intensities is applied to model default events. Our specification assumes that the stochastic intensity has a linear relationship with macroeconomic and firm-specific variables. In the doubly-stochastic formulation of the point process for default proposed by Duffie et al. (2007), the conditional probability of default within τ years is given by:

$$q(X_t, \tau) = E\left(\int_t^{t+\tau} e^{-\int_t^z (\lambda(u)+\varphi(u))du}\,\lambda(z)dz \middle| X_t\right) \tag{1}$$

where X_t is the Markov state vector of firm-specific and macroeconomic covariates, and λ_t (i.e. the conditional mean arrival rate of default measured in events per year) is a firm's default intensity. Firms can also exit the market for other reasons, such as merger and acquisition or transfer of the business to other firms. In this case, the intensity is defined as φ_t. The total exit intensity is therefore $\lambda_t + \varphi_t$.

The forward default intensity is given by:

$$f_t(\tau) = exp\big(\alpha_0(\tau) + \alpha_1(\tau)X_{t,1} + \alpha_2(\tau)X_{t,2} + \cdots + \alpha_k(\tau)X_{t,k}\big) \tag{2}$$

and the forward combined exit intensity is defined as:

$$g_t(\tau) = f_t(\tau) + exp\big(\beta_0(\tau) + \beta_1(\tau)X_{t,1} + \beta_2(\tau)X_{t,2} + \cdots + \beta_k(\tau)X_{t,k}\big) \tag{3}$$

We use the pseudo-likelihood function, as in Duan et al. (2012), to estimate the forward default intensity. The details of the derivation of its large sample properties can be found in Appendix A of the paper by Duan et al. (2012). In short, the pseudo-likelihood function for the prediction time τ is defined as:

$$\mathcal{L}_{\tau}(\alpha,\beta;\tau_C,\tau_D,X)=\prod_{i=1}^{N}\prod_{t=0}^{T-1}\mathcal{L}_{\tau,i,t}(\alpha,\beta), \qquad (4)$$

with the sample period running from 0 to T with annual frequency. Firm i first appears in the sample at t_{0i}, while τ_{Di} is the default time and τ_{Ci} is the combined exit time. During the sample period, if firm i exits because of default, then $\tau_{Di} = \tau_{Ci}$, otherwise $\tau_{Ci} < \tau_{Di}$. In our model, X_{it} are the covariates that include common factors and firm-specific variables. The prediction horizon τ is measured in years with $\Delta t = 1$, and α and β are the model parameter sets for default and other exit processes, respectively.

According to the double stochastic assumption (also known as the conditional independence assumption), firms' default probabilities only depend on common factors and firm-specific variables and are independent of each other (i.e. the default of one firm will not influence other firms' exit probabilities).

The likelihood function $\mathcal{L}_{\tau,i,t}(\alpha,\beta)$ allows for five possible cases for firm i. In the prediction time period, it can survive, default,[5] or exit for other reasons (which, in our sample, means that the insurance firm transferred its business to other firms). Therefore, default risk in our model is strictly speaking associated with insolvency risk. It can also exit after or before the prediction time period:

$$\begin{aligned}\mathcal{L}_{\tau,i,t}(\alpha,\beta)\\ = 1_{\{t_{0i}\le t,\tau_{Ci}\ge t+\tau\}}P_t(\tau_{Ci}>t+\tau)+1_{\{t_{0i}\le t,\tau_{Di}=\tau_{Ci}\le t+\tau\}}P_t(\tau_{Ci};\tau_{Di}=\tau_{Ci}\le\\ t+\tau)+1_{\{t_{0i}\le t,\tau_{Di}\ne\tau_{Ci},\tau_{Ci}\le t+\tau\}}P_t(\tau_{Ci};\tau_{Di}\ne\tau_{Ci},\&\,\tau_{Ci}\le t+\tau)+\\ 1_{\{t_{0i}>t\}}+1_{\{t_{Ci}<t\}}\end{aligned} \qquad (5)$$

The pseudo-likelihood function $\mathcal{L}_{\tau,i,t}(\alpha,\beta)$ can be maximized numerically to obtain the estimated parameters $\hat{\alpha}$ and $\hat{\beta}$.

[5] Default events are collected from SynThesys Non-Life and include insolvent, in liquidation, placed in administration and dissolved.

3. Data and Descriptive Statistics

We employ a unique dataset made available by the Bank of England (BoE) where firm-specific variables are collected from SynThesys Non-Life, which has been supplied by the general insurance division of the Bank of England. It consists of FSA (Financial Service Authority, now regulated under the Prudential Regulation Authority of the Bank of England) non-life annual return regulatory data. This database gives us access to FSA returns data for the current year and previous years, back to 1985 until 2014. Firms in our dataset are subject to Solvency I, while from 1st January 2016 UK firms are subject to Solvency II.

SynThesys Non-Life system covers more than 500 companies. The data include statements of solvency, components of capital resources, statements of net assets, calculations of capital requirement, analysis of admissible assets, liabilities, the profit and loss account, analysis of derivative contracts, summary of the business carried out, technical account, analysis of premiums, analysis of claims, analysis of expenses, and analysis of technical provisions, among others. Additionally, approximately 180 ratios are included, with all the calculations done by SynThesys.

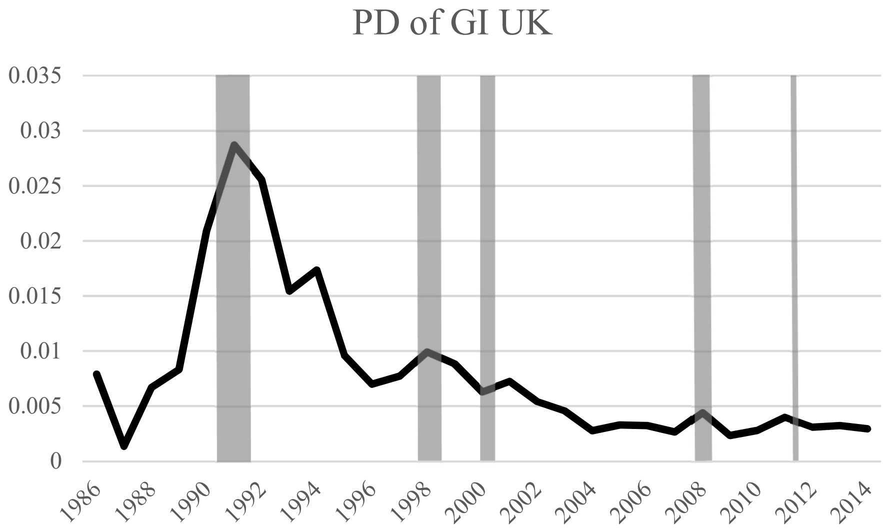

Figure 1. Aggregate Default Risk and Natural Disasters. The aggregate default risk is defined as the simple average of the default probability of all firms. The shaded areas denote natural disaster periods.

Figure 1 shows the aggregate default risk over periods of natural disasters, where the probabilities of default have been estimated according to the model described in Section

2.[6] The aggregate default risk is a simple cross-sectional average of the probability of default (PD) of all firms. Periods of natural disasters are associated with higher probabilities of default. Default probabilities change significantly and increase substantially when firms face unexpected losses.

4. Default risk and insurance firms

There is a significant body of literature modelling default risk to value financial instruments (see for example, Duffie and Singleton, 1995; Longstaff and Schwartz, 1995). This is not the objective of our paper, although some of our results can also relate to the large literature, mainly in the equity arena and using data for public firms, investigating the existence of anomalous cross-sectional properties of equity returns for financially distressed firms. For example, Vassalou and Xing (2004) have shown that there is a significant informational content in size and book-to-market, which helps to explain why there is a higher return for stocks issued by different firms. They show that book-market and size effects are mainly concentrated in firms with high probability of default and these generate high returns.

Campbell et al. (2008) show that highly financially distressed firms generate lower stock returns in the future. This result calls into question the benefit of diversifying risk and higher premium compensation for higher risk. Garlappi and Yan (2011) reconcile the empirical evidence above by considering financial leverage. It is interesting to note that our paper, using firms' regulatory data as opposed to market equity data, reaches similar conclusions as in Campbell et al. (2008).

[6] For example, in 1990: The Burns' Day storm happened on 25-26 January 1990 across North-Western Europe and was one of the strongest European windstorms. It hit during the daytime and caused huge damage. There was severe flooding in England, and insurers in the UK lost £3.37bn; it was the UK's most expensive weather event for insurers. 1990-1991: There was an extremely cold winter in Western Europe. In the UK snow began to fall on the night of 7 December 1990 in the Midlands, Wales and the Pennines. Transport was severely disrupted, and many people were trapped in their cars; moreover, there were power losses in many areas across the UK, and heavy rains and severe gales around Christmas and the New Year caused great damage to thousands of homes. There was more heavy snow in early February 1991 during the coldest winter since 1987. Temperatures stayed very low until 20 February.
In 1998 Easter floods: Heavy rain started to fall on 9 April in the Midlands and then moved northwards, causing severe floods. Thousands of housed were affected. 2000: Severe flooding across the UK.
In 2007: Floods affected Gloucestershire, Yorkshire, Hull and Worcestershire and caused £6 million damage. 2008: Morpeth floods. There was flooding in the Midlands and North-East England. £40 million damage. 2009: In February 2009, heavy snow in the UK resulted in £1.3 billion damage. In November 2009, heavy rain caused flooding in many areas across the UK.
In 2012: Great Britain and Ireland floods: Most of UK experienced droughts in March, which was followed by the wettest April in 100 years. Heavy rains continued until July and resulted in flooding across the country. Widespread flooding and wind damage occurred in September, November, December and January 2013.

This paper speaks to that part of the insurance literature that has moved away from the traditional Capital Asset Pricing Model (CAPM) to option pricing models, which incorporate default risk into the pricing model (Doherty and Garven, 1986; Cummins, 1988). Option models of insurance can explicitly incorporate default risk. These models see the liabilities created by issuing policies as analogous to risky corporate debt. A common feature of these models is that they predict a negative relationship between default risk and the value of insurance policies. Clearly, the latter should incorporate the likelihood of the insurer's solvency. Is default risk an important driver of insurance returns? Answering this question is important, as the price set by insurance companies is important to manage underwriting risk. Normally, an insurer's underwriting profitability depends on how well it understands the risks (in this example underwriting and market risks) it insures against and how well it can reduce the costs associated with managing claims. The premium should be sufficient to cover expected incurred claims.

We are not aware of any empirical paper investigating this important issue, although there is a large theoretical literature on this topic. We undertake a detailed empirical analysis to shed some light on it by exploiting a very large dataset and, differently from other studies, its cross-sectional dimension.

An important element of our paper, which follows from the option pricing models of insurance valuation, is that we assume that policyholders (at least on aggregate) are lending money to insurers. Therefore, the insurer's default risk becomes an important element affecting returns. Option Pricing Models of insurance would predict that lower underwriting returns are associated with higher default risk. We shall discuss it in more details in Section 5.

An important novel aspect of our paper is that we have data on core (non-core) firms' returns and therefore, we can split returns into underwriting and investment returns. These related activities have been characterized by quite different performances in the last thirty years. The underwriting return is the profit generated by an insurer's underwriting activities and corresponds to the difference between the premium collected and incurred claims. This is a measure of the efficiency of an insurer's core business activities. The investment return is the yield from the premium invested by the insurer on non-core assets.

Because of their peculiarities, these two major components of insurance total asset returns have shown to behave distinctively across time. Hence, the risk compensation for underwriting and investment returns should also be different.

As for the underwriting return, insurance firms protect individuals and corporations from losses, such as natural disasters (Adams et al., 2003; Faure and Heine, 2011; Kugler and Ofoghi, 2005; Ward and Zurbruegg, 2000), and the underwriting return is the price for potential claims from policyholders. Insurance firms are exposed to unique risks from catastrophes, resulting in barrier option-like return characteristics and implying that underwriting returns are generally uncorrelated with returns from the rest of the market.

As for investment returns, unlike other financial institutions, insurers do not accept deposits from customers, and the policy cancelation process takes a long time; therefore, they do not face the liquidity risk caused by bank runs. The insurance firms normally reinvest the premium obtained from policyholders to get excess returns. It follows that investment activities might be more sensitive to the market.

We start with a simple example where we use the panel model described in Section 2 to compute forward-looking probabilities of default. Thereafter, we sort portfolios based on different default risk (i.e. from low to high probability of default). We calculate the probability of default for each firm at the end of next year and use it to sort portfolios and compute the (equal-weighted) portfolio returns next year. Descriptive statistics for the five insurance portfolios with underwriting and investment returns can be found in Table 1. The upper panel shows the underwriting returns, and the lower panel shows the investment returns between 1985 to 2014.

Table 1

Portfolio Returns

This table shows the descriptive statistics for underwriting (upper panel) and investment (lower panel) returns of our sample companies (years 1985 to 2014). Portfolio 1 includes the 20% insurance firms with the lowest default risk, whereas portfolio 5 includes the 20% insurance firms with the highest default risk. (returns are % annualized)

Underwriting Return					
Portfolio	1	2	3	4	5
Mean	2.31	0.36	-0.61	-1.39	-2.82
Median	3.21	0.54	-0.31	-1.26	-2.71
Max	6.47	3.60	3.06	1.23	0.62
Min	-3.10	-5.65	-7.11	-6.35	-7.69
Std	0.03	0.03	0.02	0.02	0.02
Skewness	-0.52	-1.04	-0.90	-1.01	-0.49
Kurtosis	2.16	4.02	3.51	3.78	3.10
Investment Return					
Mean	4.67	3.82	3.10	2.47	1.64
Median	4.27	3.61	3.09	2.42	1.79
Max	7.73	6.72	4.96	3.64	2.62
Min	2.26	1.61	1.33	0.85	0.22
Std	0.01	0.01	0.01	0.01	0.01
Skewness	0.25	0.22	-0.18	-0.44	-0.28
Kurtosis	2.14	2.39	1.99	2.32	2.70

Table 1 shows underwriting and investment returns. For underwriting returns, the mean returns monotonically decreases when moving from portfolio 1 to portfolio 5, and both the average and median returns are negative for portfolio 3 to portfolio 5. Risk, as measured by the standard deviation, is quite stable across the five portfolios, while the large negative skewness suggests crash risk across these portfolios. For investment returns, skewness is instead positive for low default risk portfolio but, again, it becomes negative when default risk increases.

In short, Table 1 suggests that low default risk firms outperform high default risk firms in terms of underwriting (investment) returns. This result is in line with the insurance literature supporting option pricing models of insurance valuation. In this paper, we aim to investigate what drives this negative relationship.

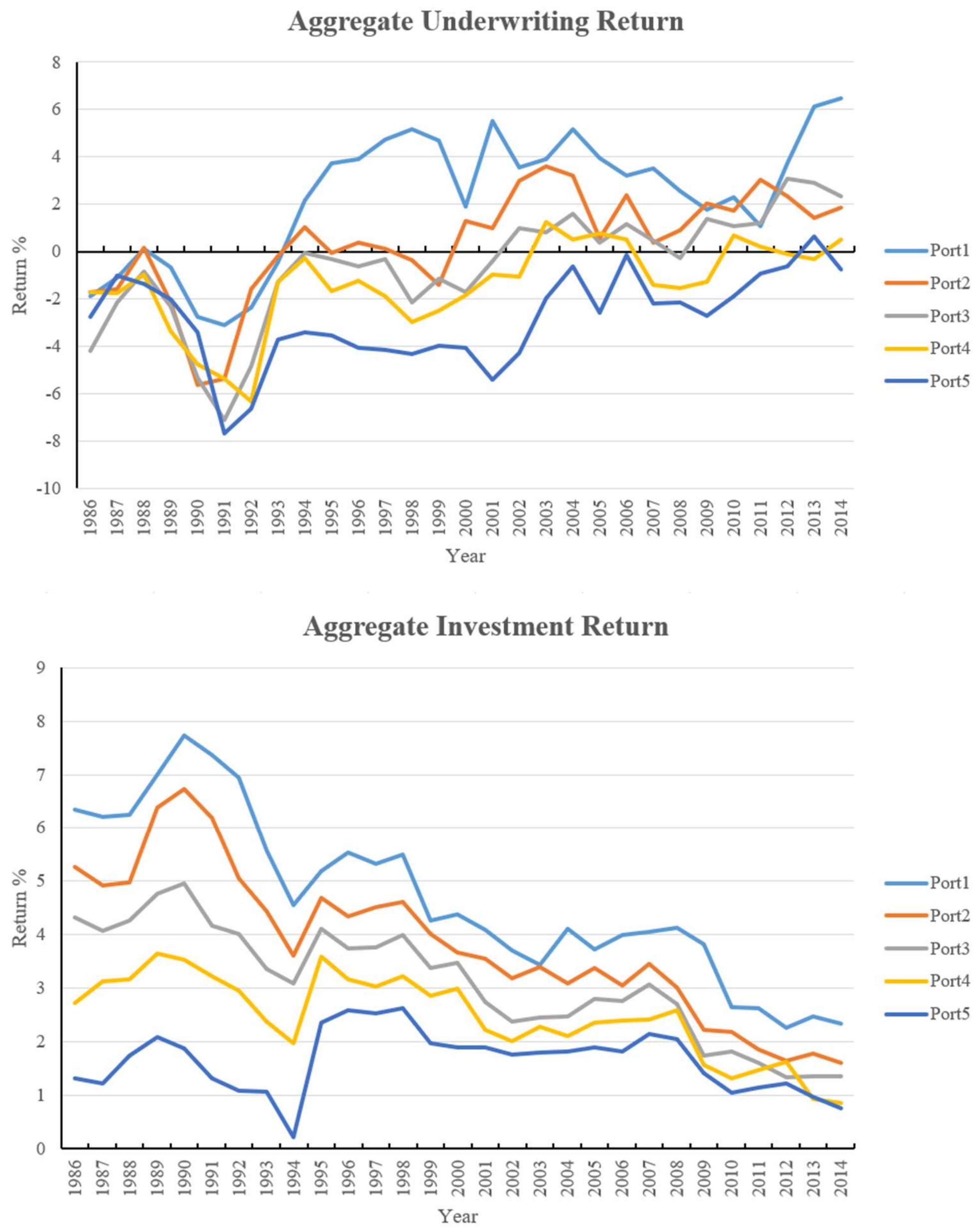

Figure 2. Returns to Insurance Portfolios. The upper panel shows the underwriting returns of general insurance firms. The light blue, orange, grey, yellow, and dark blue lines correspond to the returns of portfolio 1, portfolio 2, portfolio 3, portfolio 4, and portfolio 5, respectively. The lower panel shows the investment returns of general insurance firms. The light blue, orange, grey, yellow, and dark blue lines correspond to the returns of portfolio 1, portfolio 2, portfolio 3, portfolio 4, and portfolio 5, respectively. The sample years are 1985 to 2014. Portfolio 1 includes the 20% of insurance firms with the lowest default risk, whereas portfolio 5 includes 20% insurance firms with the highest default risk.

Figure 2 shows these portfolios over different periods. It shows that all portfolios have a similar trend across the sample period for both underwriting and investment returns. Firms with low default risk (e.g. portfolio 1 and portfolio 2) show better performance most of the time. The underwriting returns drop significantly during the early 1990s for all the portfolios. This is not surprising, because, at that time, natural disasters frequently hit the UK, so insurers suffered huge losses. Since then, all firms' returns show an upward trend. Investment returns exhibit a decreasing trend across the five portfolios during the sample period, except for two increases in the late 1990s.

4.1 Size and reinsurance effects

What drives the negative relationship between firms' return and default risk? Firm's size is normally one of the key factors when analysing the insurer's performance and default risk, as it is generally believed that large firms are 'too big to fail'. Large firms tend to focus on riskier business (which increases the default risk) and might also be more associated with the financial industry. Thus, these firms might be riskier. On the other hand, insurance firms are exposed to catastrophe risk (e.g. floods, earthquakes), which suggests that small firms could be more vulnerable to this type of risk than the large ones.

Generally, central banks classify the risk of insurers according to the size of the firm. Bouzouita and Young (1998) find that large insurers are less likely to become insolvent, because they normally benefit from economies of scale and, given their sizeable market shares and higher ratings, they have lower financing costs than small insurers (Adams et al., 2003). Recent studies (e.g. Caporale et al., 2017) challenge these results and show that size is not significant in explaining the insurer's insolvency risk.

There is a large literature on size and default risk in the insurance industry but it is far from reaching a clear-cut conclusion. In this paper, we investigate if size can fruitfully help us to explain the returns-default risk relationship in the insurance industry. We employ a novel cross-sectional (asset pricing) analysis.

A second firm's characteristic that we consider is reinsurance risk. Firms can manage default risk via the reinsurance market in two different ways: first, a firm can buy (re) insurance policies issued by other firms to cover for the risk against a fee's payment. Alternatively, firms can cede part of their assets to another firm in return for cash using, for example, the financial market. In this paper, we use the ratio of reinsurance premium ceded to gross premium written.

The literature on insurance suggests that large firms tend to use more reinsurance contracts to manage default risk. However, given the complex relationship between primary insurers, reinsurers, and financial markets, it is unclear if primary insurers can reduce risk by expanding their reinsurance activities. Caporale et al. (2017) find that reinsurance activity is associated with the default risk of insurance firms in the UK. This evidence is in line with a stream of literature that links reinsurance to default risk (the so-called 'bankruptcy cost hypothesis').

In general, large part of the literature views reinsurance as a hedging contract that enables primary insurers to transfer risks to a third party (see, for example, Aunon-Nerin and Ehling, 2008). In these studies, reinsurance is a hedging tool available to the firm to manage default risk, and they point out the different advantages linked to this operation: for example, corporate hedging decisions, such as reinsurance, affect the strategic performance of a firm (Harris and Raviv, 1991; Adam et al., 2007).

Harrington and Niehaus (2003) argue that reinsurance is important because solvency risk matters to both policyholders and regulators, and Upreti and Adam (2015) find that reinsurance enables primary insurers to have sufficient risk capacity for planning and pricing new business lines.

In this paper, we aim to investigate if (how) reinsurance can drive the negative relationship between firms' return and default risk. In doing that, we also try to shed some light on other important issues, for example, whether reinsurance can become a risk channel linking the insurance industry to the financial market. In fact, under the new regulatory regime (i.e. the *Solvency II*), reinsurance assets are listed separately from cash and financial assets in insurance firms' balance sheets, and the technical provision (i.e. provisions for expected future claims) of reinsurance is now part of liabilities.

The renting capital hypothesis predicts that firms might use reinsurance and financial markets to rent capital in order to increase leverage and this could impact firms' returns. Reinsurance activities link different (leveraged) insurers together, and it may act as a contagion channel in the system in times of distress, so the risk from reinsurance activities might be very important to the whole general insurance industry in times of financial shocks (see, for example, Acharya and Richardson, 2009).

Table 2

Correlation and Explanatory Power of Default Risk

In this table, 'Default' denotes the aggregate default risk, 'Dol_underwriting' refers to the average underwriting return of all five sorted portfolios, and 'Dol_investment' is the average investment return. 'PD' denotes the default probability. The standard errors are estimated following the Newey and West (1987) method, and R-squared is adjusted for degrees of freedom.

Panel A: Correlation Between Default Risk and Other Factors

	Default	Size	Reinsurance
Default	1.00	-0.48	0.73
Size	-0.48	1.00	-0.80
Reinsurance	0.73	-0.80	1.00

Panel B: Time-Series Regression of Risk Factors on Default Risk

Factor		Constant	PD	R^2
Reinsurance	Coef	0.27	2.77***	0.51
	s.e.	0.01	0.417	
Size	Coef	12.2	-25.3 ***	0.21
	s.e.	0.16	9.330	
Dol underwriting	Coef	0.01	-2.30***	0.68
	s.e.	0.01	0.311	
Dol investment	Coef	0.02	0.80***	0.31
	s.e.	0.01	0.244	

Panel A of Table 2 shows the correlation coefficients between default risk, size, and reinsurance for our sample data. Default risk is positively correlated with reinsurance (0.7292) but negatively correlated with size (-0.4848). These results suggest that size and reinsurance might contain potentially significant default-related information. In Panel B we run some simple ordinary least squares (OLS) regressions. It shows that reinsurance and size can explain a substantial portion of default risk and the coefficients are highly significant. We also include two additional factors: Dol under-writing and Dol investment referring to underwriting and investment, respectively.[7] Returns from core business are negatively related to default risk while those from non-core business are positively related to default risk. Overall, these results are consistent with those portrayed in Table 1 and suggest that size and reinsurance are

[7] The Dol factor is the simple average of five portfolios (i.e. the average of all firms); we include the Dol factor to see the relationship between aggregate default risk and asset returns.

likely to be important characteristics to understand the negative relationship between returns and default risk.

Table 3

Portfolios Sorted Using Default Risk

From 1986 to 2014, we use the default risk of each firm to sort all portfolios into quintiles. We then compute the equally weighed returns of each portfolio the next year. 'Underwriting returns' denotes the average portfolio underwriting return, and 'Investment returns' denotes the average portfolio investment return. Portfolio 1 is the one with the lowest default risk, and portfolio 5 is the one with the highest default risk. Default risk is expressed in basis points, and the return in percentage (returns are % annualized, default risk in basis points).

	Low				High
	1	2	3	4	5
Underwriting returns	2.31	0.36	-0.61	-1.39	-2.82
Investment returns	4.67	3.82	3.11	2.47	1.64
Average Size	11.64	11.90	12.10	12.90	13.05
Average Reinsurance	0.17	0.21	0.30	0.39	0.48

In Table 3, after sorting portfolios according to the (expected) probability of default (from Low to High), and, besides the average returns for each portfolio, we display the average size and reinsurance levels. While returns decline monotonically as default risk increases, size and reinsurance clearly increase. Furthermore, high default risk firms are also the largest firms in the sample as well as those firms more exposed to the reinsurance market. Given that the insurance literature on size, reinsurance and default risk is yet far from reaching a clear cut conclusion on how (if) size and reinsurance are associated with default risk, we aim to shed some light on this important issue in the next sections.

4.2 Do size and reinsurance matter for firms' returns?

To understand if size and reinsurance are important drivers of the (negative) relationship between default risk and returns, we switch to a two-stage sort approach. Differently from other studies, we use a cross sectional analysis rather than a time series one to better exploit the informational content of our dataset. By doing this, we focus on the insurance sector as a whole rather than on the individual firm. Additionally to that, we employ a portfolio approach (focusing on the cross-sections) in order to disentangle the size-default risk relationship under a new perspective and show that size represents a significant firm's characteristic which helps us to understand the relationship between default risk and firms' returns.

We first define the 'size effect' as the positive average return differential between small and large size firms (already discussed in a previous section). As before, we use firms' (expected) default risk to sort portfolios into quintiles and compute the equally weighed returns of each portfolio next year. Within each portfolio, firms are sorted into five size portfolios, equally-weighted average returns from sequential sorts are reported in Table 4 (which therefore considers 25 portfolios overall), where 'PD' denotes the probability of default (default risk), 'Small' the small-sized firms, and 'Big' the big sized-firms. 'Small-Big' is the return difference when buying smallest-size firms and selling biggest-size firms within each default quantile (whose significance is measured through the reported *t*-values).

Table 4

Size Effect Controlled by Default Risk

From 1986 to 2014, we use the default risk of each firm to sort current portfolios into quintiles. We then compute the equally weighed returns of each portfolio of the next year. Within each portfolio, firms are then sorted into five size portfolios. 'PD' denotes the probability of default (default risk), 'Small' the small-sized firms, and 'Big' the big sized-firms. 'Small-Big' is the return difference between the smallest size and biggest size portfolios within each default quantile. *t*-values are calculated from Newey–West standard errors. *** denotes significance at the 1 percent level.

	Small				Big		
	1	2	3	4	5	Small-Big	*t*-value
Panel A: Average Underwriting Return							
Low PD 1	4.50	3.01	0.99	0.01	-0.77	5.37	4.59***
2	2.64	0.39	-0.18	0.31	-1.14	3.78	3.98***
3	1.04	-0.68	-0.86	-0.96	-1.75	2.79	3.41***
4	-0.35	-1.43	-1.18	-1.09	-1.59	1.24	1.54
High PD 5	-0.10	-2.08	-1.81	-1.43	-1.72	0.72	0.95
Panel B: Average Investment Return							
Low PD 1	4.53	4.25	4.45	4.01	4.00	0.53	1.16
2	4.01	3.72	3.69	3.59	3.52	0.47	1.29
3	3.50	3.22	3.10	2.86	3.35	0.14	0.46
4	3.11	2.40	2.25	2.27	2.80	0.30	1.01
High PD 5	1.84	1.78	1.78	1.90	2.02	-0.18	-0.77
Panel C: Average PD							
Low PD 1	12.99	14.03	13.80	13.86	14.11		
2	28.77	28.94	28.82	28.61	29.05		
3	45.81	46.38	47.36	45.18	45.88		
4	73.41	75.22	76.33	73.60	72.05		
High PD 5	233.66	242.13	198.56	192.00	179.56		
Panel D: Average Reinsurance							
Low PD 1	0.1287	0.2482	0.1922	0.1637	0.1494		
2	0.1719	0.2496	0.2243	0.2009	0.1756		
3	0.2610	0.3464	0.3046	0.3272	0.2266		
4	0.3154	0.3602	0.3942	0.4095	0.3059		
High PD 5	0.3681	0.4254	0.4977	0.4504	0.4483		
Panel E: Average Size							
Low PD 1	9.16	10.71	11.79	12.82	14.54		
2	9.19	10.70	11.98	13.03	14.53		
3	9.58	11.07	12.23	13.17	14.71		
4	9.83	11.36	12.43	13.30	14.73		
High PD 5	10.03	11.42	12.28	12.97	14.44		

Table 4, Panel A, shows that for underwriting returns there is a size effect within the quantile containing firms with low to moderate default risk (PD1, PD2, and PD3) and if firms are small in size (see Panel E). For PD1, the average return difference of small-sized firms and big-sized firms is remarkable (5.36 percent p.a.) and it is highly significant. As for the remaining two quantiles (PD4 and PD5), no significant difference is found. The size effect seems to be mainly concentrated in small firms with low to moderate default risk and low levels of reinsurance. Thus, our (cross sectional) portfolio approach allows us to detect results which had previously been ignored in other works. For example, Caporale et al. (2017) did not find firm's size relevant in explaining default risk.

Panel C shows that the default risk for portfolio PD1-PD3 is significantly less than portfolio PD4 and PD5. Panel D shows that reinsurance activity increases significantly as default risk increases particularly for large firms. In sum, size does contain important default related information.

Finally, Panel B shows the results for investment returns. In this case, the size effect is not present, since no significant average return difference between small and big firms emerges. This suggests that such an effect is not present within any segment of the market.

Table 5

Reinsurance Effect Controlled by Default Risk

From 1986 to 2014, we use the default risk of each firm to sort all portfolios into quintiles. Within each portfolio, firms are then sorted into five reinsurance portfolios. The equally-weighted average returns of the portfolios for the next year are reported below. 'PD' denotes the probability of default (default risk), 'Low Reinsurance' denotes firms with low reinsurance ratio, and 'High Reinsurance' denotes firms with high reinsurance ratio. 'Low-High' is the return difference between the lowest reinsurance and the highest reinsurance portfolios. *t*-values are calculated from Newey–West standard errors. *, **, *** denote significance at the 10 percent level, the 5 percent level, and the 1 percent level, respectively.

	Low Reinsurance			High Reinsurance		
	1	2	3	4	5	Low-High	*t*-value
Panel A: Average Underwriting Return							
Low PD 1	4.35	1.07	0.53	1.01	0.82	3.52	3.60***
2	1.98	-0.10	-0.90	0.31	0.59	1.39	1.52
3	0.65	-0.81	-1.44	-0.92	-0.70	1.35	1.56
4	-0.66	-1.85	-1.02	-1.39	-0.71	0.05	0.06
High PD 5	-1.47	-2.29	-2.22	-1.13	-0.89	-0.58	-0.86
Panel B: Average Investment Return							
Low PD 1	4.54	4.85	4.37	4.00	3.45	1.10	2.53**
2	3.95	3.97	3.86	3.58	3.17	0.78	1.90
3	3.50	3.59	3.18	3.03	2.68	0.81	2.38**
4	3.10	2.94	2.60	2.32	1.87	1.23	4.55***
High PD 5	2.31	2.34	1.88	1.66	1.16	1.15	4.73***
Panel C: Average PD							
Low PD 1	12.92	14.42	13.66	14.20	13.61		
2	27.99	28.44	28.20	29.76	29.72		
3	45.04	45.54	46.37	46.38	47.22		
4	72.09	74.68	74.11	73.61	76.10		
High PD 5	194.13	188.33	234.87	214.38	206.28		
Panel D: Average Reinsurance							
Low PD 1	0.01	0.04	0.10	0.23	0.50		
2	0.01	0.06	0.13	0.27	0.55		
3	0.03	0.12	0.25	0.41	0.66		
4	0.05	0.17	0.31	0.50	0.75		
High PD 5	0.10	0.25	0.43	0.60	0.82		
Panel E: Average Size							
Low PD 1	10.67	12.33	12.41	11.92	11.64		
2	10.72	12.58	12.46	12.05	11.71		
3	11.84	12.51	12.21	12.31	11.92		
4	11.88	12.85	12.44	12.43	12.09		
High PD 5	12.01	12.26	12.26	12.26	12.34		

Summing up: a) small firms with low or moderate default risk show the highest returns; b) default risk increases dramatically for high-risk firms. We now turn to investigate if a 'reinsurance effect' exists.

The Bank of England (2016) states that "complex reinsurance arrangements exist in the market", and therefore they expect appropriate counterparty credit risk in place. Risk arising from reinsurance activity could be very pervasive and spread quickly to the rest of the insurance industry and, probably, to the financial industry overall (Acharya and Richardson, 2009). Therefore, increasing re-insurance activity can become very risky.

In Table 5, we investigate whether a reinsurance effect exists. We sort insurance firms into five quantiles according to the default risk. In the second stage, firms within each default quantile are sorted into five reinsurance portfolios. Hence, there are 25 portfolios overall, through which we explore the possible presence of a reinsurance effect in the various default risk quantiles.

Table 5 shows the results for both types of returns. From Panel A, concerning the underwriting returns, we see that the reinsurance effect is only present within the lowest default quantiles (PD1) and if a firm is small in size (see Panel E). In this case, the difference between firms with low reinsurance activity and firms with higher reinsurance activity is economically large (3.50 percent p.a.). Besides, risky firms tend to have lower underwriting returns. There is no significant difference in the remaining quantiles.

On the other side, we note that a large and significant reinsurance effect exists for investment returns. The reinsurance effect is associated stronger to very risky firms. The results in Table 5 are intriguing as they suggest that, while for underwriting returns a reinsurance effect might only exist for (small) firms with low default risk, it is the opposite for investment returns.

The average return difference between the smallest and the largest firms is about 1.10 percent p.a. for PD1, 0.81 percent p.a. for PD3, 1.23 percent p.a. for PD4, and 1.15 percent p.a. for PD. The significant evidence of a reinsurance effect for investment returns may point towards a greater importance of reinsurance in high risky insurance firms (highly distressed firms). Another possibility is that firms use the reinsurance market to free up capital, not to support the core business, but to leverage and expand their non-core business activity (Renting Capital Hypothesis) becoming increasingly interconnected with the financial markets. We shall investigate it in the second part of this paper.

The results in Panel C suggest that the highest default risk firms in PD5 are almost 15 times riskier than small firms in PD1. In sum, reinsurance does contain default related information and this is particularly significant for investment returns.

It is interesting to note that the above results, combined with those for underwriting returns (Panel A), suggest that the large average return that small-low-default firms (PD1) earn, compared to the rest of the market, is reward for focusing on core-business: better underwriting abilities, pricing strategies, and investment performance.

4.3 Return and risk relationship after controlling by size and reinsurance

We found that size and reinsurance effect exists for insurance firms. In this section, we investigate if default risk also exists in the data and explore its empirical relationship with firms' returns. We first sort insurance firms by size (reinsurance) and thereafter we sort portfolios based on default risk. We start investigating the return-default risk relationship after controlling by size and define the 'default effect' as the positive average return differential between low and high default risk firms.

We use firm's size to sort all portfolios into quantiles, within each portfolio we sort firms into five additional portfolios by default risk. The equally-weighted average returns of the portfolios of the next year are reported in Table 6, where – as before – 'PD' denotes the probability of default (default risk), 'Small' denotes the small-sized firms, and 'Big' denotes the large-sized firms. 'Low-High' is the return difference from buying the lowest default risk firm and selling the highest default risk one within each size quantile (we again assess its significance by means of *t*-values).

Table 6

Default Effect Controlled by Size

From 1986 to 2014, we use the firm size of each firm to sort all portfolios into quintiles. Within each portfolio, firms are then sorted into five portfolios by default risk. The equally-weighted average returns of the portfolios for the next year are reported below. 'PD' denotes the probability of default (default risk), 'Small' denotes the small-sized firms, and 'Big' denotes the large-sized firms. 'Low-High' is the return difference between the lowest default risk and highest default risk portfolios within each size quantile. *t*-values are calculated from Newey–West standard errors. *, **, *** denote significance at the 10 percent level, the 5 percent level, and the 1 percent level, respectively.

	Low PD				High PD	Low-High	*t*-value
	1	2	3	4	5		
Panel A: Average Underwriting Return							
Small 1	5.17	4.51	1.62	-0.27	-2.46	7.63	6.93***
2	2.64	0.19	-0.52	-0.90	-3.15	5.80	6.35***
3	2.05	-0.49	-0.82	-2.17	-3.07	5.12	7.79***
4	0.65	-0.23	-0.28	-1.31	-2.28	2.93	4.09***
Big 5	-0.68	-1.54	-1.21	-1.93	-2.47	1.80	2.24**
Panel B: Average Investment Return							
Small 1	4.62	4.13	3.63	3.15	2.05	2.56	6.20***
2	4.49	3.97	3.23	2.66	1.75	2.74	7.01***
3	4.36	3.54	2.83	2.32	1.51	2.85	8.56***
4	4.21	3.21	2.41	2.01	1.46	2.75	9.74***
Big 5	4.64	3.77	3.15	2.65	1.97	2.67	10.34***
Panel C: Average PD							
Small 1	10.14	22.13	34.97	57.13	205.25		
2	13.06	26.38	41.95	69.03	227.90		
3	15.76	33.52	52.70	87.72	281.30		
4	19.96	39.33	63.06	99.97	251.34		
Big 5	17.18	33.53	50.49	74.25	176.45		
Panel D: Average Reinsurance							
Small 1	0.15	0.18	0.19	0.23	0.32		
2	0.20	0.22	0.32	0.39	0.45		
3	0.20	0.24	0.32	0.42	0.49		
4	0.18	0.24	0.35	0.47	0.545		
Big 5	0.13	0.17	0.23	0.30	0.40		
Panel E: Average Size							
Small 1	9.26	9.15	9.18	9.47	9.57		
2	10.84	10.90	10.86	10.86	10.90		
3	11.96	12.05	12.03	12.07	11.99		
4	12.96	12.99	13.00	12.93	12.94		
Big 5	14.55	14.47	14.59	14.63	14.60		

Panel A exhibits some interesting and novel results, we start with underwriting returns. There is a strong and economically large default effect and the return-risk relationship is statistically significant across the size, although small size firms, overall, do better. Therefore, the relationship between default risk and returns is solid even controlling by size. We also note a monotonic decline in returns while moving from PD1 to PD5.

These results extend to investment (non-core) returns. The empirical relationship between default risk and returns is still very significant.

To confirm that that relationship is empirically reliable, Panel C shows that higher default risk portfolios carry a significantly higher risk than low-risk portfolios. There is a substantially large variation in terms of default risk across insurance portfolios. Panel D shows the results for re-insurance activity. This increases with the default risk.

In Table 7, we investigate the validity of the negative relationship between default risk and returns after controlling for reinsurance. As with Table 6, we first sort portfolios according to reinsurance, and, for each portfolio, we then sort firms into five portfolios by default risk. We still report the equally-weighted average returns of the portfolios. 'PD' denotes the probability of default (default risk), 'Low Re' denotes the firms will low reinsurance ratio, and 'High Re' denotes the firms with high reinsurance ratio. Finally, 'Low-High' is the return difference between the lowest default risk and highest default risk portfolios within each reinsurance quantile (*t*-values measure its significance).

Table 7

Default Effect Controlled by Reinsurance

From 1986 to 2014, we use the reinsurance of each firm to sort all portfolios into quintiles. Within each portfolio, firms are then sorted into five portfolios by default risk. The equally-weighted average returns of the portfolios for the next year are reported below. 'PD' denotes the probability of default (default risk), 'Low Re' denotes the firms will low reinsurance ratio, and 'High Re' denotes the firms with high reinsurance ratio. 'Low-High' is the return difference between the lowest default risk and the highest default risk portfolios within each reinsurance quantile. *t*-values are calculated from Newey–West standard errors. *, **, *** denote significance at the 10 percent level, the 5 percent level, and the 1 percent level, respectively.

	Low PD				High PD		
	1	2	3	4	5	Low-High	*t*-value
Panel A: Average Underwriting Return							
Low Re 1	5.21	2.28	2.01	0.03	-1.36	6.57	5.66***
2	2.02	-0.40	-0.39	-1.90	-3.29	5.31	5.34***
3	1.70	-0.26	-1.30	-1.70	-3.91	5.62	6.82***
4	1.65	0.07	-1.40	-1.33	-2.87	4.52	6.63***
High Re 5	1.26	-0.05	-0.83	-0.89	-2.63	3.90	6.56***
Panel B: Average Investment Return							
Low Re 1	4.72	4.32	3.89	3.48	2.48	2.24	5.11***
2	5.13	4.43	3.74	3.43	2.65	2.48	7.17***
3	4.49	3.55	3.17	2.65	2.10	2.39	7.82***
4	4.00	3.18	2.71	2.19	1.69	2.31	7.78***
High Re 5	3.19	2.40	1.84	1.58	1.11	2.08	7.50***
Panel C: Average PD							
Low Re 1	10.05	19.98	29.37	43.04	110.26		
2	11.50	23.17	32.56	49.66	126.29		
3	15.76	31.32	49.02	77.56	213.73		
4	21.03	42.01	62.70	104.99	272.66		
High Re 5	27.76	54.34	83.59	129.96	331.48		
Panel D: Average Reinsurance							
Low Re 1	0.01	0.02	0.02	0.02	0.02		
2	0.10	0.09	0.10	0.10	0.10		
3	0.22	0.22	0.22	0.23	0.24		
4	0.39	0.42	0.40	0.41	0.41		
High Re 5	0.68	0.65	0.71	0.72	0.72		
Panel E: Average Size							
Low Re 1	10.81	10.98	10.86	11.48	11.22		
2	12.40	12.69	12.71	12.92	13.03		
3	11.85	12.29	12.17	12.42	12.22		
4	11.65	12.01	12.27	12.23	12.15		
High Re 5	11.42	11.88	12.41	12.37	12.25		

The default effect is strong and economically large even after controlling for re-insurance: low default risk firms (lower reinsurance) earn higher returns. These results might be consistent with the adverse selection hypothesis (Stiglitz, 1977). Primary insurers (cedant) are more informed than reinsurers, hence, the higher the asymmetry the higher is the cost (the lower the profit) of re-insurance for the cedant.

The results in Table 7 confirm the empirical validity of the negative relationship between default risk and firms' returns. In addition to that, Panel C confirms that there is a positive relationship between default risk and re-insurance: firms with higher default risk use the reinsurance market more aggressively. This might imply that highly distressed firms are the ones using the reinsurance market more aggressively. Alternatively, these results might also imply that insurance firms use the reinsurance market to leverage increasing, in this way, the interconnection with the financial markets.

Interestingly, results in Table 7 suggest that both underwriting and investment returns are exposed to the same risk, i.e. default risk. This result is at odd with some standard models of insurance risk (e.g., Hammond et al., 1976), in fact it suggests that these two key sources of revenue (underwriting and investment returns) could be exposed to a common risk. We shall investigate it in Section 6.

5. Policy Discussion

The results in the previous sections provide clear support for the options pricing models of insurance. They also show that size and reinsurance are important to understand that relationship. Finally, they conjecture an "adverse" role of re-insurance, used by firms to invest on risky (non-core) projects. We shall investigate it further in the next sections. These results have important implications for policymakers and financial stability.

The insurance industry has mainly used the Capital Asset Pricing (CAPM) model to estimate the (systematic risks) beta and the insurance price, while the default risk has been largely neglected because of the existence of a customers' guaranty insurance fund. The foremost problem is that, given the complexity of the insurance-reinsurance-financial markets relationship, such fund could be rather limited. What is the effect on the insurance returns after including default risk? As the option pricing models of insurance predict, the insurance price will be lower and insurance returns decline. This is exactly what we observe in the data for the UK market. Therefore, it seems that the market can already determine a "fair price" for insurance without an excessive need for regulation.

Another important result that we have highlighted in the previous sections is that there is a positive relationship between insolvency risk and reinsurance activity, which also impacts negatively on firms' (either underwriting and investment) returns. This evidence finds theoretical support in the adverse selection hypothesis (Stiglitz, 1977).

If we just consider the traditional reinsurance market, when an insurance firm buys reinsurance, it buys a security and it pays for it, therefore reducing its expected profit, given that firms are ceding profits worth on average 10% or more of their gross premium written, this translates in a significant amount of premium ceded to the reinsurance firm. Therefore, our results cast doubt on the profitability of the UK insurance industry as highly dependent on the reinsurance market, particularly highly distressed ones.

An intriguing aspect of this is the following: as insurers and re-insurers use the same financial market and both face default risk, why should reinsurance firms be willing to pay a high cost by taking the risk away from very risky primary insurers? One possible answer is that, since reinsurers are less informed than insurers about the quality of the risks they are taking, their risk estimate of insolvency is not accurate (Jean-Baptiste, 2000). If this is the case, then its consequence is worrying as it implies an increase of systemic risk within the insurance industry (see also discussion below).

Our results (particularly using investment returns) support the Rental Capital Hypothesis, which predicts that risky insurance firms use the reinsurance market to raise cheap capital and invest in high risky projects. For example, given that the difference in terms of (default) risk between low reinsurance firms (10bp) and high reinsurance firms (331bp) is very large, we could, reasonably, conjecture that this large risk premium may be due to (very risky) non-core business. We shall investigate this further in the next sections. In sum, our results call into question the risk management tool used by UK insurance firms to diversify risk, underwriting risk, in primis, but also credit risk.

6. Robustness Checks

In the next sections we shall use a battery of tests to confirm and enhance on the results reported above. We start with the results in the Appendix 2, Tables A1-A2, where we replace underwriting returns with policy premium (in percentages) and repeat the analysis of Tables 6 and 7. Overall, the empirical results are consistent and somehow even stronger than the ones presented in Table 6 and 7.

Figure 1 has clearly shown that the early 1990s have been very difficult years for the insurance industry in the UK, and our results in Tables 6 and 7 might have been driven by unexpected episodes over the sample period; in other words, they might be ascribed to in-sample events that are unlikely to occur in the future.

In order to test this hypothesis, we have removed all observations between the years 1985 to 1994. The new results in Tables 8 and 9, are, overall, consistent with those in Tables 6 and 7.

Table 8

Default Effect Controlled by Size 1995-2014

From 1995 to 2014, we use the firm size of each firm to sort all portfolios into quintiles. Within each portfolio, firms are then sorted into five portfolios by default risk. The equally-weighted average returns of the portfolios for the next year are reported below. 'PD' denotes the probability of default (default risk), 'Small' denotes the small-sized firms, and 'Big' denotes the large-sized firms. 'Low-High' is the return difference between the lowest default risk and highest default risk portfolios within each size quantile. *t*-values are calculated from Newey–West standard errors. *, **, *** denote significance at the 10 percent level, the 5 percent level, and the 1 percent level, respectively.

	Low PD				High PD	Low-High	*t*-value
	1	2	3	4	5		
Panel A: Average Underwriting Return							
Small 1	7.01	6.44	3.22	0.83	-2.35	9.37	7.69***
2	4.14	0.99	0.58	-0.21	-3.01	7.16	8.70***
3	2.84	0.61	-0.02	-2.03	-2.87	5.71	7.56***
4	1.26	0.22	0.45	-0.97	-1.36	2.63	3.43***
Big 5	0.51	-0.70	-0.27	-1.17	-1.60	2.11	3.18***
Panel B: Average Investment Return							
Small 1	3.86	3.35	2.93	2.74	2.24	1.62	3.75***
2	3.67	3.29	2.52	2.29	1.84	1.82	5.04***
3	3.70	2.98	2.48	2.22	1.79	1.91	6.44***
4	3.60	2.99	2.23	1.94	1.48	2.12	8.09***
Big 5	4.02	3.28	2.87	2.34	1.88	2.14	10.03***
Panel C: Average PD							
Small 1	8.88	18.15	26.83	41.65	90.89		
2	12.13	23.30	35.10	51.79	136.02		
3	13.65	26.38	39.58	62.91	152.64		
4	14.52	26.20	38.68	58.37	139.67		
Big 5	13.86	25.81	38.41	57.38	113.85		
Panel D: Average Reinsurance							
Small 1	0.14	0.17	0.19	0.21	0.31		
2	0.20	0.20	0.34	0.36	0.47		
3	0.21	0.21	0.28	0.37	0.46		
4	0.17	0.20	0.32	0.45	0.55		
Big 5	0.11	0.16	0.23	0.30	0.40		
Panel E: Average Size							
Small 1	9.39	9.12	9.18	9.57	9.63		
2	10.96	11.08	10.99	10.98	11.00		
3	12.14	12.28	12.24	12.28	12.20		
4	13.22	13.24	13.22	13.20	13.16		
Big 5	14.71	14.70	14.71	14.83	14.89		

Table 9

Default Effect Controlled by Reinsurance 1995-2014

From 1995 to 2014, we use the reinsurance of each firm to sort all portfolios into quintiles. Within each portfolio, firms are then sorted into five portfolios by default risk. The equally-weighted average returns of the portfolios for the next year are reported below. 'PD' denotes the probability of default (default risk), 'Low Re' denotes the firms will low reinsurance ratio, and 'High Re' denotes the firms with high reinsurance ratio. 'Low-High' is the return difference between the lowest default risk and the highest default risk portfolios within each reinsurance quantile. *t*-values are calculated from Newey–West standard errors. *, **, *** denote significance at the 10 percent level, the 5 percent level, and the 1 percent level, respectively.

	Low PD				High PD	Low-High	*t*-value
	1	2	3	4	5		
			Panel A: Average Underwriting Return				
Small 1	7.64	3.58	3.43	1.55	-0.96	9.37	7.51***
2	3.24	1.16	0.58	-0.91	-2.28	7.16	5.83***
3	1.76	1.08	-0.04	-1.40	-2.50	5.71	4.79***
4	2.87	0.66	-0.48	-1.12	-2.98	2.63	7.79***
Big 5	1.44	0.15	-0.48	-1.36	-1.92	2.11	6.10***
			Panel B: Average Investment Return				
Small 1	3.86	3.46	2.96	2.97	2.34	1.52	3.44***
2	4.41	3.53	3.38	2.94	2.38	2.03	7.10***
3	3.91	3.19	2.68	2.60	2.13	1.78	7.14***
4	3.44	2.77	2.36	2.09	1.88	1.57	5.33***
Big 5	2.70	2.10	1.61	1.60	1.29	1.42	5.32***
			Panel C: Average PD				
Small 1	8.84	17.47	25.46	36.92	72.00		
2	9.98	18.55	25.60	37.22	74.69		
3	14.16	24.01	34.12	51.72	101.25		
4	14.66	29.48	41.55	59.97	122.39		
Big 5	20.78	42.05	62.62	100.57	219.65		
			Panel D: Average Reinsurance				
Small 1	0.01	0.01	0.01	0.01	0.01		
2	0.08	0.08	0.08	0.08	0.08		
3	0.19	0.19	0.19	0.20	0.20		
4	0.38	0.39	0.40	0.39	0.41		
Big 5	0.68	0.70	0.73	0.75	0.77		
			Panel E: Average Size				
Small 1	10.76	10.74	10.67	11.53	11.63		
2	12.84	13.02	12.79	13.18	12.69		
3	12.19	12.66	12.15	12.36	12.45		
4	11.85	12.15	12.48	12.60	12.22		
Big 5	11.45	12.17	12.56	12.56	12.46		

6.1 An asset pricing approach

In the previous sections, we pointed out that both underwriting and investment returns are exposed to the same factor, default risk. In this section we study the relationship between firms' returns and default risk (given the level of reinsurance) using an asset pricing (time series and cross sectional) approach. Note that, the short time series dimension of our dataset might affect the estimations of the time series betas.

We use the Fama and MacBeth (1973) methodology. For both types of returns, we first sort portfolios according to reinsurance, obtaining five portfolios (from PF1, with lowest reinsurance, to PF5, with highest reinsurance). For each of these portfolios, we then estimate their (default risk) factor's betas. Such values should provide us with a proxy of how (core-business and non-core business) returns in the insurance industry comove with the industry risk across different level of re-insurance.

Table10

Fama and MacBeth (1973) Regression Approach (FMB)

This table presents time series (cross-sectional) results for the linear factor model based systemic risk. The systemic risk factor is simply constructed by taking the average of all active firms' PD in each year. We test the underwriting/investment return to five portfolios based on sorting the firm's according to reinsurance activity (from lowest to highest reinsurance). The factor risk price, λ is obtained by FMB cross-sectional regression. Standard errors (s.e.) are reported in parentheses and are calculated by the Newey and West (1987) procedure with optimal lag selection according to Andrews (1991). The cross-sectional R-squared is also reported. The sample period is 1986 to 2014, data from PRA return are annual.

Underwriting return				Investment return			
PF	**PD**		R^2	**PF**	**PD**		R^2
1	-1.71	***	0.15	**1**	1.12	***	0.22
	0.5630				*0.4088*		
2	-2.19	***	0.32	**2**	0.89	***	0.30
	0.5699				*0.2516*		
3	-1.89	***	0.31	**3**	0.53	**	0.14
	0.6060				*0.2383*		
4	-1.89	***	0.55	**4**	0.35		0.06
	0.3256				*0.2370*		
5	-1.59	***	0.66	**5**	0.31		0.06
	0.2431				*0.2067*		
FMB			R^2	**FMB**			R^2
Λ	0.02	***	0.24	Λ	0.02	***	0.66
s.e.	*0.0055*			**s.e.**	*0.0038*		

*** significant at 1%
** significant at 5%
* significant at 10%

We start with underwriting returns. For all portfolios, the estimated betas are highly significant and negative. Thus, these portfolios have a negative and significant exposure to aggregate default risk, meaning that, when default risk increases, they are likely to earn lower returns. This is consistent with the negative relationship between default risk and returns predicted by option pricing models and reinsurance appear to be important in driving this relationship. The market price of risk (i.e. λ) is positive and highly significant: firms with larger exposure to (aggregate) default risk carry larger risk premium. This is also consistent with the option pricing models of insurance. In sum, these results appear to confirm that reinsurance is important to understand the negative relationship between firms' return and default risk in the insurance industry.

As for investment returns, portfolios with low or medium reinsurance are characterised by positive (and significant) betas, hence they have a positive (and significant) exposure to default risk. This means that, when aggregate default risk increases, these portfolios earn higher returns. This also suggest that when industry (default) risk increases, insurance firms tend to expand their non-core business, and this is particularly true for firms within the low to moderate reinsurance group. The market price of risk (λ) is highly significant and positive, suggesting that there is a positive relationship between default risk exposure and the market price of risk.

In sum, these results, first, confirm the empirical evidence of a negative and significant relationship between firms' returns and default risk in the UK insurance industry. Second, they confirm that reinsurance is an important driver of this relationship. Finally, default risk affects both underwriting and investment returns. This result points towards an increasing significant role of systemic risk within the insurance sector.

7. The insurance industry and the financial markets

We have pointed out the possibility of tighter interconnections between the financial markets and the UK insurance industry and that this effect takes place via the reinsurance channel. In Figure 3 we present a simple (prima facie) empirical evidence of this.

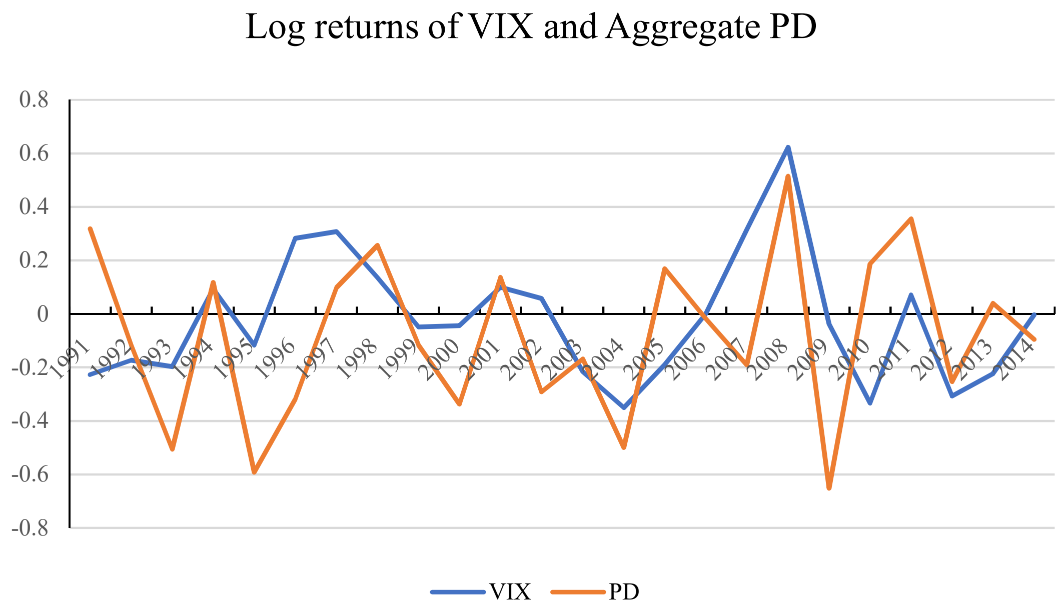

Figure 3. Log returns of VIX and Aggregate PD. The figure shows the log returns of VIX and aggregate PD of general insurance firms (see also Figure 1 for aggregate PD). Sample years are 1990 to 2014.

We plotted the VIX (i.e. the Volatility Index of the Chicago Board Options Exchange – CBOE – that measures the level of risk stress in the market) and the (aggregate) PD (here representing a proxy for default risk in the insurance industry). Their relationship over time is fairly evident. Figure 3 shows a higher relevance of the association between the insurance industry and the external financial environment. The correlation between log returns of VIX and aggregate PD is positive and far from negligible (0.34), which is consistent with the view that, when risk aversion increases, default risk in the insurance industry increases too. Therefore, risks in the market and insurance industries are correlated.

It is interesting to note the association of the firms' default risk and the VIX during the 2008-09 financial crisis. There is a huge spike in default risk and VIX during that period. As Cerrato et al. (2017) pointed out, the high probability of default of the insurance firms during that period suggests that the insurance industry might be exposed to the financial markets condition. However, Cerrato et al. (2017) did not conduct further research on this important issue.

We use the fixed effects panel regression in Equation (6) and investigate the relationship between firms' cash holdings and reinsurance. We control for firm's specific factors such as underwriting profit (Underwriting), investment return (Investment), short-term leverage (ST Leverage), long-term leverage (LT Leverage), firm size (Size), cash ratio (Cash), change of gross premium written (GPW), reinsurance ratio (Reinsurance), change of incurred claims (Claim), growth ratio (Growth), and Herfindahl index (H_index), derivative (Derivative) and mutual (Mutual) dummy. D_i represents the individual fixed effect, Y_i represents the time fixed effect, and ε_{it} is a residual term.

$$\begin{aligned} Cash_{i,t} = \alpha &+ \beta_1 underwritting_{i,t-1} + \beta_2 Investment_{i,t-1} + \beta_3 ST\ leverage_{i,t-1} \\ &+ \beta_4 LT\ leverage_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 GPW_{i,t-1} \\ &+ \beta_7 Reinsurance_{i,t-1} + \beta_8 Claim_{i,t-1} + \beta_9 Growth_{i,t-1} \\ &+ \beta_{10} H\_index_{i,t-1} + \beta_{11} Derivative_{i,t-1} + \beta_{12} Mutual_{i,t-1} \\ &+ \delta D_i + \lambda Y_i + \varepsilon_{i,t-1} \end{aligned} \tag{6}$$

In Table (11) we investigate the effect of reinsurance on firms' cash holdings. We expect that firms use reinsurance to free up capital to be used either to write new policies or for investment.

Table 11. Cash and Reinsurance

	Coef.	
Under_lag1	0.04	
	0.0419	
Inv_lag1	0.30	**
	0.1372	
Lev_lag1	0.05	**
Rein_lag1	-0.03	**
Constant	0.62	**
	0.0434	
Adjusted R^2	0.6825	

*** significant at 1%
** significant at 5%
* significant at 10%

Results in Table (11) confirm a significant association between high level of cash and reinsurance, and suggest that insurance firms do not use reinsurance to window dressing their balance sheets.

Are insurance firms using the reinsurance market to support non-core business (Renting Capital Hypothesis: Shiu, 2011)? We investigate the relationship between firm's short-term leverage (Net Technical Provisions /Adjust Liquid Assets) and reinsurance. We use the same fixed effects panel model as in Equation (6), where cash holding is now replaced by firms' leverage (see Equation 7).

$$\begin{aligned} ST\ leverage_{i,t} = \alpha &+ \beta_1 underwritting_{i,t-1} + \beta_2 Investment_{i,t-1} \\ &+ \beta_3 LT\ leverage_{i,t-1} + \beta_4 Cash_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 GPW_{i,t-1} \\ &+ \beta_7 Reinsurance_{i,t-1} + \beta_8 Claim_{i,t-1} + \beta_9 Growth_{i,t-1} \\ &+ \beta_{10} H\_index_{i,t-1} + \beta_{11} Derivative_{i,t-1} + \beta_{12} Mutual_{i,t-1} \\ &+ \delta D_i + \lambda Y_i + \varepsilon_{i,t-1} \end{aligned} \tag{7}$$

Table 12. ST Leverage and Reinsurance

	Coef.	
Under_lag1	-0.52	***
	0.0728	
Inv_lag1	-1.28	***
	0.2392	
Rein_lag1	-0.18	***
	0.0219	
Constant	0.16	**
	0.0775	
Adjust R^2	0.7152	

*** significant at 1%
** significant at 5%
* significant at 10%

Table (12) shows the results. There is a negative and significant association between leverage and reinsurance. Capital freed up by firms' reinsurance is not used to support core-business (if firms were to write new policies, technical provisions should have increased) but for investments.

Taken together, results in Tables 11 and 12, and the results presented in the previous sections, suggest that insurance firms, in general, do not always use the reinsurance market to support the core business. These results are a warning for regulators that UK firms, on aggregate, support non-core business via the reinsurance market increasing, in this way, the systemic risk within the industry and reinforcing a risk transmission channel with the financial markets.

7. Conclusions

This paper uses PRA returns data of more than 500 UK insurance firms from 1985 to 2014 to investigate the theoretical predictions of the Option Pricing Models of insurance. We split data into underwriting and investment returns and, consistently with the theoretical predictions, we report a negative relationship between underwriting returns and default risk. We discuss some policy implications. We also investigate if size and reinsurance can help us to explain this negative relationship (i.e. if they contain default related information), finding evidence that reinsurance is related to default risk and that this feeds into firms' returns. This is a new and interesting result and it has important policy implications. Finally, we find that underwriting and investment returns are exposed to a unique (default) risk factor, and that reinsurance is likely to act as a risk transmission channel between the insurance industry and financial markets. We conclude that the UK insurance industry can contribute to pose systemic risk given its growing intermediator role in financial markets.

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Appendix 1.

Variable	**Definition**
Underwriting return	The underwriting return is the profit generated by an insurer's underwriting activities; the difference between the premium collected and incurred claims.
Investment return	The investment return reported in the PRA form.
Size	The natural logarithm of total admitted assets.
Reinsurance	The ratio of reinsurance premium ceded to gross premium written.
Default risk	The default probability (calculated following the method from Caporale et al., 2017).

Appendix 2.

Table A1 Default Effect Controlled by Size (premium %)

From 1986 to 2014, we use the firm size of each firm to sort all portfolios into quintiles. Within each portfolio, firms are then sorted into five portfolios by default risk. The equally-weighted average underwriting premium change and investment return of the portfolios for the next year are reported below. 'PD' denotes the probability of default (default risk), 'Small' denotes the small-sized firms, and 'Big' denotes the large-sized firms. 'Low-High' is the difference between the lowest default risk and highest default risk portfolios within each size quantile. *t*-values are calculated from Newey–West standard errors. *, **, *** denote significance at the 10 percent level, the 5 percent level, and the 1 percent level, respectively.

	Low PD				High PD	Low-High	*t*-value
	1	2	3	4	5		
Panel A: Average Underwriting Premium Change							
Small 1	71.08	14.49	13.28	0.09	-17.81	88.89	7.26***
2	63.96	16.24	8.62	7.00	-17.13	81.08	6.86***
3	44.30	13.65	11.72	3.16	-18.07	62.37	8.54***
4	34.66	17.34	8.43	3.64	-12.01	46.67	4.08***
Big 5	19.00	7.84	6.35	6.69	-7.13	26.13	5.37***
Panel B: Average Investment Return							
Small 1	4.62	4.13	3.63	3.15	2.06	2.56	6.20***
2	4.49	3.97	3.23	2.66	1.75	2.74	7.01***
3	4.37	3.55	2.83	2.32	1.51	2.85	8.56***
4	4.21	3.22	2.41	2.01	1.46	2.75	9.75***
Big 5	4.64	3.77	3.15	2.65	1.97	2.67	10.35***
Panel C: Average PD							
Small 1	10.14	22.13	34.97	57.13	205.25		
2	13.06	26.39	41.95	69.04	227.90		
3	15.76	33.52	52.70	87.72	281.31		
4	19.96	39.33	63.06	99.97	251.35		
Big 5	17.18	33.53	50.49	74.25	176.45		
Panel D: Average Reinsurance							
Small 1	0.15	0.18	0.20	0.23	0.32		
2	0.20	0.22	0.33	0.39	0.45		
3	0.21	0.24	0.32	0.42	0.49		
4	0.18	0.24	0.35	0.47	0.55		
Big 5	0.13	0.17	0.23	0.30	0.40		
Panel E: Average Size							
Small 1	9.26	9.15	9.18	9.48	9.57		
2	10.84	10.91	10.86	10.86	10.90		
3	11.96	12.05	12.03	12.08	11.99		
4	12.96	12.99	12.98	12.93	12.94		
Big 5	14.55	14.47	14.59	14.63	14.61		

Table A2 Default Effect Controlled by Reinsurance (premium %)

From 1986 to 2014, we use the reinsurance of each firm to sort all portfolios into quintiles. Within each portfolio, firms are then sorted into five portfolios by default risk. The equally-weighted average underwriting premium change and investment return of the portfolios for the next year are reported below. 'PD' denotes the probability of default (default risk), 'Low Re' denotes the firms will low reinsurance ratio, and 'High Re' denotes the firms with high reinsurance ratio. 'Low-High' is the difference between the lowest default risk and the highest default risk portfolios within each reinsurance quantile. *t*-values are calculated from Newey–West standard errors. *, **, *** denote significance at the 10 percent level, the 5 percent level, and the 1 percent level, respectively.

	Low PD				High PD		
	1	2	3	4	5	High-Low	*t*-value
Panel A: Average Underwriting Premium Change							
Low Re 1	44.98	12.02	5.62	5.97	-5.56	50.54	5.33***
2	39.09	14.38	10.17	4.44	-4.93	44.02	5.59***
3	43.88	10.88	6.94	2.22	-10.02	53.90	7.58***
4	47.01	13.55	5.26	-0.03	-12.14	59.14	5.54***
High Re 5	64.55	12.28	6.70	-0.80	-21.40	85.95	6.30***
Panel B: Average Investment Return							
Low Re 1	4.72	4.32	3.89	3.48	2.48	2.24	5.11***
2	5.13	4.43	3.74	3.43	2.65	2.48	7.17***
3	4.49	3.55	3.17	2.65	2.10	2.39	7.82***
4	4.00	3.18	2.71	2.19	1.69	2.31	7.78***
High Re 5	3.19	2.40	1.84	1.58	1.11	2.08	7.50***
Panel C: Average PD							
Low Re 1	10.06	19.99	29.37	43.04	110.26		
2	11.50	23.17	32.56	49.66	126.29		
3	15.76	31.32	49.02	77.56	213.73		
4	21.03	42.01	62.70	104.99	272.66		
High Re 5	27.76	54.34	83.59	129.96	331.48		
Panel D: Average Reinsurance							
Low Re 1	0.02	0.02	0.02	0.02	0.02		
2	0.10	0.09	0.10	0.10	0.10		
3	0.22	0.22	0.22	0.23	0.24		
4	0.39	0.42	0.40	0.41	0.41		
High Re 5	0.68	0.66	0.71	0.72	0.72		
Panel E: Average Size							
Low Re 1	10.81	10.98	10.86	11.48	11.22		
2	12.40	12.69	12.72	12.92	13.03		
3	11.85	12.29	12.17	12.42	12.22		
4	11.65	12.01	12.27	12.23	12.15		
High Re 5	11.42	11.88	12.41	12.37	12.25		